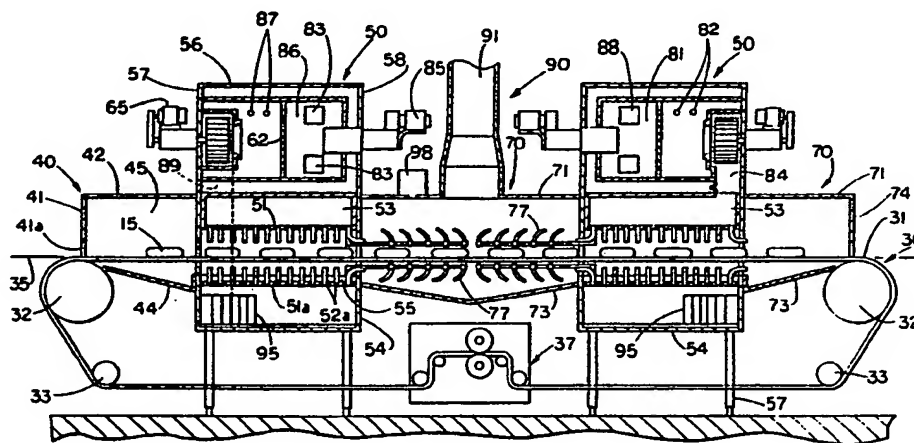




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(54) Title: METHOD AND APPARATUS FOR PULSE HEATING AND COOKING FOOD PRODUCTS



(57) Abstract

There is provided a continuous feed oven (10) for heating and cooking a food product (15), and including a conveyor (30) for continuously moving product (15) through the oven along a substantially longitudinal path (35). A plurality of spaced high velocity impingement zones (50) are located along the longitudinal path (35) of the oven, with each such zone having a plurality of spaced air jets (52, 52a) for impinging gases at predetermined elevated temperatures, humidity and at predetermined high velocities against the outer surfaces of products being conveyed along such conveyor (31). A relaxation zone (70) is integrally interposed between each adjacent impingement zone (50), with the relaxation zone (70) effectively isolating adjacent impingement zones (50) from one another and providing an equilibration space having a temperature substantially equal to the predetermined elevated temperatures of the preceding impingement zone (50). The velocity of movement of gases within the relaxation zone (70) is substantially lower than in adjacent impingement zones (50), whereby a product (15) passes through a series of alternating high velocity impingement (50) and low velocity relaxation zones (70) such that an effective thermal pulsing heat application is provided to the product (15) at predetermined elevated temperatures substantially above the desired finished temperature of the product (15).

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METHOD AND APPARATUS FOR PULSE HEATING
AND COOKING FOOD PRODUCTS

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I. Technical Field.

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This invention relates to an improved method and apparatus for pulse heating and cooking of various food products, and, more particularly, to a method and apparatus for pulse heating and cooking which features the predetermined alternation of thermal periods, wherein processing gases are impinged at high velocities and at a predetermined humidities and elevated temperatures against the outer surfaces of a food product, with relaxation periods wherein a predetermined elevated temperature is maintained and the velocity of the gases is substantially reduced to enable equilibration of the temperature gradients within the food product.

25

II. Background Art.

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Conventionally, food products have been heated and cooked in one of two ways: (1) either they were processed in a high-temperature apparatus whose interior temperature was well above the temperature at which food typically undergoes cooking (i.e. cooking typically occurs between about 140° and about 200° F) for relatively short periods of time, or (2) were processed in a low-temperature cooking apparatus (e.g. about 200° F) for long periods of time. The deleterious effects of

1 high-temperature cooking is widely recognized, as such
cooking is destructive to nutrients, vitamins and
valuable soluble constituents of the food, and tends to
rob the food of taste and flavor. With conventional
5 low-temperature cooking, the oven temperature is
maintained at or only slightly higher than the cooking
temperature of the food, and nutrients, valuable
constituents, taste and flavor are better preserved.
However, because the results in heat differential between
10 the food to be cooked and the interior temperature of the
apparatus is relatively small, the cooking time in a
low-temperature apparatus is often prohibitively
extended.

15 U.S. Patent 4,374,319, which issued to Raul Guibert
on February 15, 1983, discusses an oven device which
allegedly can accomplish low-temperature cooking of food
more efficiently and more rapidly than conventional low-
temperature ovens. In particular, in the Guibert '319
20 oven, air is circulated within a box-like housing by a
suction fan which pulls the air through the oven and past
the food held within and past electric resistance heater
elements in a circular pattern. There are specifically
two heating coils which can be thermostatically
25 controlled during operation. An electronic control
circuit operates to switch both the fan and the heater
elements on and off periodically so that there are
periods of hot air flow past the food, and distinct
intervals wherein there is no air flowing in the oven and
30 the temperature is reduced. The resulting pulsatory heat
wave produced in the oven thereby includes hot air pulses
whose temperature is substantially above the cooking
temperature of the food, and distinct no-flow periods
where the temperature of the outer surface of the food is
35 allowed to cool down so that cooking can be carried out

1 at a low-temperature, and so that no part of the food
body is ever heated above its low-temperature cooking
level. Guibert also suggests that the no-flow periods
could be accomplished by a baffle arrangement within the
oven which could intermittantly deflect the air flow to
5 prevent it from circulating past the food item. Similar
pulsatory heat wave units are shown and described in
other U.S. patents which issued to R. Guibert, including
U.S. Patents 4,381,442; 4,381,443; and 4,455,478.

10

A hot air oven for heating food cartridges is shown
in U.S. Patent 4,132,216 which issued to R. Guibert on
January 2, 1979. In particular, the '216 patent shows a
hot air oven for heating a predetermined number of food-
loaded cartridges designed to rapidly raise the
15 temperature of pre-cooked food or other products
characterized by low thermal conductivity; and,
thereafter, to maintain the product at a predetermined
heated temperature without overcooking. The food-loaded
cartridges are arranged on a rotating turntable and are
20 caused to be cyclicly rotated through a hot zone and an
extra-hot zone. The extra-hot zone has a temperture well
above the serving temperature of the food product so that
a marked temperature differential exists between the
heated air and the food, even as the food within the
25 cartridges approaches serving temperature. An arcuate
shield formed within the device acts to restrict the
passage of heated air through holes formed in a carton
surrounding the food-loaded cartridges when in the hot
zone, preventing air from flowing around such cartridges.
30 On the contrary, a propeller blows heated air through the
holes of the cartons surrounding the cartridges when in
the extra-hot zone to heat the food in the trays. The
flow of heated air in the extra-hot zone is designed to
35 accelerate the rate of heat-up of the food cartridges

1 such that the time/temperature curve remains relatively
steep throughout the entire heating procedure. A curtain
of heated air surrounds the circular apparatus to provide
access to the heated food trays while substantially
5 containing the heat within the device. A similar
two-zone hot air rotating oven is also shown in U.S.
Patent 4,307,286 which also issued to R. Guibert.

A combination microwave and impingement heating
10 apparatus is shown in U.S. Patent 4,409,453, which issued
to D. Smith on October 11, 1983. In particular, the
Smith '453 device includes a microwave oven which has
been adapted to include a system of air jets above and
below a food product held therewithin, with such air jets
15 designed to accomplish surface browning and relatively
uniform heating of the surfaces of odd shaped food
products. In particular, relative movement between the
food product and the air being discharged allegedly
produces a "sweeping" or "wiping" action to provide
20 uniform heating. Microwave energy is employed to heat
the interior portions of the food product. The Smith
patent also suggests the use of the combination hot air
jet/microwave apparatus in a continuous manner wherein
the means for supporting the food product comprises a
25 continuous wire mesh conveyor. Again, the columnated jet
of heated air is described as impinging the surface of
the food product in a wiping action to penetrate the
boundary layer of air surrounding the food product which
would normally form an insulation barrier. The rate of
30 heat transfer from the heated jets of air to the food
products is set forth as being greater than the rate of
migration of moisture from the center of the food product
to the exterior surface thereof. In this way, browning
of the food product can be accomplished without excessive
35 removal of moisture therefrom.

1 Similar cooking apparatuses are shown in several
other U.S. patents issued to D. Smith, including U.S.
Patent 4,154,861; 4,338,911; 4,289,792; and 3,884,213.

5 Additionally, continuous feed air jet ovens have
been employed in the industry wherein a product to be
cooked is initially heated or tempered in a first zone to
slowly raise the temperature of the product at a moderate
10 cooking temperature range. Once heated to a moderate
cooking temperature, browning of the outer surface of the
food product is achieved by impinging the product with
high velocity air heated well above (e.g. between about
800° and 1000° F) the cooking temperature of the food
15 product. After browning has been completed by the high
velocity heated air, the heat applied to the product
during the initial tempering and the high velocity
browning phases is allowed to migrate to the center of
the product in an equilibration zone heated to a moderate
20 cooking temperature. In this way, initial tempering,
rapid browning, and equilibration are undertaken in
distinct phases of varying temperatures and air
velocities.

25 Despite all of this previous work undertaken, there
remain problems in efficiency and quality which have
heretofore not been addressed. In particular, in the
pulsatory heat wave apparatuses taught in the Guibert
patents, generally only a limited number of food products
or food product containers could be processed at any
30 given time. Additionally, the versatility of the systems
was severely limited in that processing conditions, such
as the humidity level of heated air circulated
therewithin, could not easily be varied during any
particular heating or cooking cycle. These prior
35 apparatuses required the inefficient switching of fans,

1 heater elements and/or damper structures to divert heat
and/or air flow during their "no-flow" processing cycles.
Similarly, with the Guibert rotary-type heating and
5 cooking devices, versatility of the system was extremely
limited as only a relatively small number of food items
could be processed at any given time, and a relatively
extended cooking time was necessary because at least half
of the processing was accomplished at slow-cooking
temperatures.

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While the Smith references contemplated use of their
combination microwave/impingement heating apparatus in a
continuous mode, cooking with microwave energy often
fails to properly render blood, fat and other undesirable
15 substances from particular food products, and the
constant hot air impingement browning procedures can
cause certain portions of the food product to be
overcooked or burned. Likewise, heretofore, the
continuous feed air-jet type ovens have employed
20 tempering and equilibration zones having relatively low
temperatures maintained generally within the
low-temperature cooking range of a particular food
product. Therefore, while these known processes and
apparatuses could achieve various low-temperature food
25 product qualities, they each suffered from various
aspects of the inherent inefficiencies of low-temperature
cooking.

III. Disclosure of the Invention.

30

It is an object of this invention to provide a more
efficient method and apparatus for heating and cooking
food products.

35

It is another object of the present invention to
provide a more economical and relatively rapid method and

1 apparatus for heating and cooking food products which
consistently achieves the desirable qualities and
characteristics of conventional low-temperature cooking.

5 It is yet another object of the present invention to
provide an improved method and apparatus for heating and
cooking food products which can be easily adapted to a
variety of continuous commercial applications.

10 In accordance with one aspect of the present
invention, there is provided a continuous feed oven for
heating and cooking a food product, including a conveyor
for continuously moving product through the oven along a
substantially longitudinal path. A plurality of spaced
15 impingement zones are located along the longitudinal path
of the oven, with each such zone having a plurality of
spaced air jets for impinging gases at predetermined
elevated temperatures and humidities and at predetermined
high velocities against the outer surfaces of product
20 being conveyed along such conveyor. A relaxation zone is
integrally interposed between each adjacent impingement
zone, with the relaxation zone effectively isolating
adjacent impingement zones from one another and providing
an equilibration space having a temperature substantially
25 equal to the predetermined elevated temperatures of the
preceding impingement zone. The velocity of movement of
gases within the relaxation zone is substantially lower
than in adjacent impingement zones, whereby product
passes through a series of alternating impingement and
30 relaxation zones such that an effective thermal pulsing
heat application is provided to the product and the
predetermined elevated temperatures throughout the oven
are constantly maintained substantially above the desired
finished temperature of the product.

35

1 IV. Brief Description of the Drawing

While the specification concludes with claims particularly pointing out and distinctly claiming the present invention, it is believed that the same will be better understood from the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a flow chart generally depicting a heating and/or cooking procedure in accordance with the subject invention;

FIG. 2 is a top plan view of a continuous feed oven apparatus made in accordance with the subject invention;

FIG. 3 is a vertical cross-sectional view of the continuous feed oven of FIG. 2, taken along line 3-3 thereof;

FIG. 4 is a vertical cross-sectional view of the continuous feed oven of FIG. 2, taken along line 4-4 thereof;

FIG. 5 is a partial perspective view of an impingement zone of the subject oven, illustrating details of a preferred embodiment; and

FIG. 6 is a partial cross-sectional view of a preferred embodiment of a continuous feed oven including vertically adjustable impingement tubes and baffles.

V. Detailed Description of the Invention.

Turning now to the drawings in detail, wherein like numerals indicate the same elements throughout the views,

1 FIG. 1 illustrates a flow chart embodying the general
process of the subject invention, while FIGS. 2 through 6
include details of a preferred continuous feed oven 10 for
heating and cooking food product made in accordance with
5 the subject invention and implementing the process
illustrated in FIG. 1.

In particular, FIG. 2 is a top plan view of a
continuous feed oven 10 including, generally, an outer
10 housing 20 having a plurality of zones integrally
connected to establish a substantially unitary structure.
Oven 10 is shown as including five zones arranged in
seriatim to heat and/or cook food product 15 which is
continuously moved from left to right on a conveyor
15 system 30. Conveyor 30 preferably comprises an endless
belt 31 which is preferably formed of a porous, metallic
construction such as stainless steel or the like, but may
also be modified for use in conjunction with microwave
energy, as will be discussed in further detail below.
20 The specific structural means for conveying product 15
through continuous feed oven 10 is not critical to the
subject invention and can be accomplished by any of a
variety of conveying systems known in the art.

25 Conveyor system 30 is illustrated in FIG. 3 as
including a pair of oppositely disposed end rolls 32
about which endless belt 31 rotates, as well as a pair of
oppositely disposed idler or tension rolls 33. Product
15 to be heated and/or cooked is thereby supported on
30 belt 31 and conveyed along the longitudinal axis or
pathway 35 through oven 10 for processing. Additional
support rollers (not shown) can also be appropriately
spaced throughout the length of conveyor system 30 for
additional belt support. As will be appreciated from the
35 discussion below, belt 31 is preferably made of a porous

1 nature facilitate and permit relatively unencumbered
flow of processing gases within the system. In this
regard, it may also be preferred to provide a washing
5 mechanism (e.g. as shown generally at 37 of Figure 3)
through which belt 31 must pass as it returns to the
front end of oven 10.

Product 15 placed upon belt 31 first enters
tempering zone 40 within which product 15 is subjected to
10 processing gases such as heated air and, possibly, steam
or other predetermined humidity, which has been heated to
a predetermined elevated temperature T which is substan-
tially above the desired finished temperature or cooking
temperature of product 15. As used herein, the terms
15 "finished" or "cooking" temperature of a particular
product shall connote the minimum internal temperature to
which such product must be heated in order to be
considered "cooked". For example, the cooking or
finished temperature for chicken is about 170° F (about
20 76.6° C). This predetermined temperature T may, of
course, vary between specific applications according to
the type and size of product to be processed; the
beginning temperature of such product (e.g. depending
upon whether the product is frozen, at room temperature
25 or otherwise), the longitudinal length of tempering zone
40, the belt speed of conveyor system 30, and the like.
It should also be noted that particular parts of a
product may have a higher temperature at the completion
of the process, as some parts will be more remote or
30 insulated from the heat source. Due to the equilibration
sequences involved herein, however, any such temperature
deviations will be limited.

Tempering zone 40 may include means (not shown) for
35 providing such predetermined elevated temperature

1 therewithin, may receive heated processing gases from the
adjacent impingement zone 50 (as discussed below), or may
utilize a combination of both. Tempering zone 40 is made
up of left side wall 41 which is provided with an opening
5 or adjustable door structure 41a which optimally
minimizes the height of such opening to accommodate belt
31 and product 15 supported thereon without interference.
An adjustable door structure 41a is preferred to minimize
the amount of heat loss from the system which might
10 otherwise occur through an oversized opening.

Tempering zone 40 further comprises top wall 42,
front wall 43, opposite rear wall 45, and an inclined
bottom wall 44 which preferably forms a drip pan for
15 drainage of grease and the like emanating from various
products 15 being processed within zone 40. Preferably
the wall structures forming tempering zone 40 and the
balance of the multi-zoned housing 20 of oven 10 are
formed of a double wall construction (which might also
20 include insulation material) to retain heat and minimize
heat loss from oven 10 during use.

Tempering zone 40 is integrally connected with a
high velocity impingement zone 50 located adjacent
25 tempering zone 40 in the longitudinal direction of travel
of product 15 on conveyor system 30. Impingement zone 50
is designed to subject the tempered product to high
velocity processing gases which are substantially
uniformly impinged against the outer surfaces of product
30 15. Impingement zone 50 is illustrated as including top
wall 56 and the downwardly depending alternating left
side wall 57, front wall 59, right side wall 58 and rear
wall 59. Attached to the upper outer portions of
impingement zone 50 is an upper blower motor 60 and a
35 corresponding lower blower motor 65. Upper blower motor

1 60 is mounted for fluid communication with upper plenum
53 which is connected about its lower portions to an
upper manifold plate 51 having a plurality of spaced air
jet tubes 52 depending downwardly therefrom. Similarly,
5 lower blower motor 65 is placed in fluid communication
with a lower plenum 54 having a lower manifold plate 51a
with a corresponding plurality of air jet tubes 52a
attached thereto. As seen best in Figures 3 and 4,
blower motors 60 and 65 are each mounted oppositely from
10 a corresponding burner (80 and 85, respectively). It is
contemplated that standard pre-mix burner systems (such
as commonly available from Maxon Corporation of Muncie,
Indiana) can be used for burners 80 and 85, and the
burner flames are directed inwardly within heating
15 chambers 81 and 86, respectively, toward a baffle plate
(e.g. 62) mounted centrally within each heating chamber.
While it is contemplated that it may not always be
necessary or desirable to include this baffle plate 62,
such is generally preferred to protect the oppositely
20 disposed blower fans and help establish a turbulence
within the heating chamber. The processing air or gases
will be pulled by the blower fans through circulation
inlets 83 and 88, respectively, through heating chambers
81 and 86 and then dispersed to upper and lower plenums
25 53 and 54, respectively. Recirculated processing gases
enter the heating chambers 81 and 86 through inlets 83
and 88, respectively, and are heated by the flames of the
burners therewithin. The heated air then flows around
the central baffle (e.g. 62) and is forced into the upper
30 and lower plenums via supply conduits 84 and 89,
respectively. Humidity may also be added to the heated
processing gases, such as by steam injectors 82 and 87
located adjacent baffle plate 62 just outside heating
chambers 81 and 86, respectively. The location of such
35 steam injectors could alternatively be anywhere within

1 the recirculation pattern, such as within heating
chambers 81 and 86, adjacent inlets 83 and 88,
respectively, or within return air ducts 61 and 64,
respectively.

5

Heated processing gases (e.g. humidified air) are
thereby forced by upper blower motor 60 into upper plenum
53 and through manifold plate 51 and its depending jet
tubes 52 under predetermined pressure to impinge product
10 15 at a predetermined high velocity V_1 . Similarly, lower
blower motor 65 forces heated processing gases into lower
plenum 54 and through its corresponding manifold plate
51a and jet tubes 52a against the lower outer surfaces of
product 15. Impingement zone 50 is preferably
15 substantially larger than the adjacent tempering zone 40
in order to accommodate the high velocity impingement
apparatus as set forth above, as well as to provide
appropriate recirculation structure (e.g. return air
ducts 61 and 64) to enable such impinged processing gases
20 to be appropriately recirculated to the respective blower
motors.

In particular, it is preferred that processing gases
are recirculated both within impingement zone 50 and
25 through the adjacent tempering zone 40 and, as will be
described below, the adjacent relaxation zone 70 to
facilitate the maintenance of the predetermined elevated
temperatures within the system. It is preferred that the
manifold plates 51 and 51a and attached jet tubes 52 and
30 52a are to be mounted within the respective upper and
lower plenums 53 and 54 for easy removal and replacement
for cleaning, maintenance, repair and the like. While
spacing of individual tubes within the respective
manifold plates may be varied as desired, it is preferred
35 that such jet tubes 52 be appropriately arranged and

1 spaced apart to provide substantially uniform impingement
of product 15 regardless of its position on belt 31 as it
passes through impingement zone 50. As seen best in
Figure 4, the length of tubes 52 also provides space for
5 processing gases to move toward the oppositely disposed
return air ducts 64 and 69 of impingement zone 50 for
recirculation to heating chambers 81 and 86 without
substantially interfering with the impingement pattern of
processing gases from tubes 52. The vertical spacing of
10 tubes 52 and 52a from belt 31 will be discussed in
greater detail below.

It is also contemplated that for particular product
applications, certain of such jet tubes 52 and 52a might
15 be blocked off to correspond with product peculiarities
(e.g. whole turkeys having some very high spots and some
relatively low spots) to enable a precisely predetermined
pattern of impingement. For example, it might be preferred
that resultant processing gases impinged on high spots
20 of product 15 should be reduced to minimize potential
overcooking of such high spots, while impingement in
lower areas remains at full force. Plenums 53 and 54,
respectively, preferably extend fully across the width of
belt 31 of conveyor system 30 as well as along the length
25 of thermal zone 50, as best seen in FIGS. 3 and 4.
Return air ducts 61 and 64 are therefore preferably
confined to the front and rear portions of impingement
zone 50 laterally beyond the outer edges of the width of
belt 31. It is also preferred to include a water moat 55
30 for receiving cool water to provide a continuous source
of humidity to thermal zone 50, as well as to carry off
suspended grease and other drippings from the product and
to prevent grease fires or smoking therewithin during
processing. Additionally, the water within such moat may
35 pass across a weir (not shown) on one side thereof to

1 carry off suspended grease. Removal of such grease and
drippings minimizes pollution or smoke which might
otherwise result from grease burning on the lower
manifold. As indicated by the flow path arrows of FIGS.
5 3 and 4, heated processing gases are impinged against
product 15 from both above and below, after which such
gases are recirculated to the blower motors and burners
via return air ducts 61 and 64.

10 As seen in Figure 3, it is also preferred that some
of the air jet tubes 52 and 52a nearest the adjacent
tempering zone 40 or relaxation zones 70 are directed to
supply heated processing gases to such adjacent zones.
Because predetermined elevated temperatures substantially
15 above the cooking temperature of product 15 are to be
maintained throughout oven 10, it is not critical to
confine the heated processing gases within a particular
impingement zone 50, as such heated gases can help
maintain the elevated temperatures in the adjacent zones
20 by circulating therethrough.

Recirculated processing gases preferably pass
through some kind of filtering system (e.g. mechanical
type filters, such as shown at element 92 of FIG. 4) and
25 subsequently past the burners or other heating elements
associated with the blower motors. As described above,
the heated gases are thereafter forced by such blower
motors into respective upper and lower plenums to provide
the predetermined high velocity impingement streams via
30 tubes 52 and 52a. Impurities can thereby be removed from
the gases by the filtering apparatus and by being
consumed as they pass the burners. Mechanical filters 92
preferably comprise relatively standard reverse-vent type
elements which force the recirculated gases to undergo
35 severe directional changes as they return to the heating

1 chambers 81 and 86. Such abrupt sectional variations
cause suspended grease and impurities in the gases to be
deposited on the filters, and such deposits can
thereafter be collected for disposal, such as by a drip
5 pan or collector (e.g. drip pan 93). Filters 92 are
illustrated as preferably located within return air ducts
61 and 64, with the lower portion of ducts 61 and 64
including drip pans 93.

10 While the predetermined velocity of processing gas
issuing from the upper and lower manifold plates 51 and
51a and tubes 52 and 52a can be varied as desired, it is
contemplated that the preferred range of velocities for
such impingement is between about 4000 and about 8,000
15 fpm, although velocities outside this range might be
appropriate in particular applications. In this regard,
independent control of the blower fans and burners can
enable independent control of temperature, humidity and
velocity of processing gases being impinged from above
20 and below conveyor means 30 within a particular
impingement zone 50. For example, greater penetration of
heat into a particular product might be accomplished by
using higher velocities and/or higher temperatures from
either above or below conveyor means 30, whereby
25 increased humidity would prevent drying and/or burning of
the surface of the product by the more intense heating
provided by increased velocity and/or temperature.

As illustrated, heated processing gases issue
30 directly from upper heating chamber 81 into upper plenum
53 through supply conduit 84, while such gases are
supplied to lower plenum 54 from heating chamber 86 via
supply conduit 89. The exact location of blower motors
60 and 65, as well as their specific conduit, baffle and
35 related connecting structures are not critical to the
present invention, and can be accomplished by a variety

1 of ways known in the industry. It is, however, preferred
to locate both heating chambers 81 and 86 above their
corresponding impingement zone 50 to efficiently take
5 advantage of the recirculation pattern established
therewithin. In order to minimize impingement zone
overheating problems, it has been found preferable to
include return inlets 83 and 88 both on the upper and
lower portions of heating chambers 81 and 86 to ensure
10 that the hottest gases are pulled back into the heating
chambers for continued circulation within the oven.

Integrally attached to the right side or downstream
wall 58 of impingement zone 50 is the housing structure
of relaxation zone 70. In particular, relaxation zone 70
15 is comprised of top wall 71, front wall 72, rear wall 75,
and inclined bottom wall 73. It is preferred that an
inclined bottom wall 73 be formed to again provide a
convenient drip pan for grease and other drippings
emanating from product 15 during processing. Moreover,
20 in continuous systems designed to operate for long
periods of time, it may also be desirable to provide a
shallow water moat above wall 73 similar to water moat 55
described above. As in tempering zone 40, relaxation
zone 70 features relatively low processing gas velocity
25 (i.e. substantially lower than impingement velocity in
adjacent impingement zone 50), and is maintained at a
predetermined elevated temperature substantially equal to
(i.e. within about 20° F or about 7° C) of the
predetermined elevated temperatures of preceding
30 impingement zone 50. If different temperatures of
processing gases are being applied from above and below
product 15 in an impingement zone 50, the predetermined
elevated temperature would preferably be at least
substantially equal to the lesser of those preceding
35 impingement zone temperatures. Alternatively, the

1 elevated temperature within the relaxation zone might be
substantially equal to the average of different adjacent
impingement zone temperatures.

5 As will be seen, relaxation zone 70 serves the
critical function of both isolating adjacent impingement
zones and providing an equilibration zone wherein
temperature gradients within product 15 can be
equilibrated and reduced. Within relaxation zone 70, the
10 relatively high surface temperature of product 15
resulting from the high velocity impingement of heated
processing gases within the impingement zone 50 is given
time to migrate inwardly into product 15. Because the
elevated temperature of the preceding impingement zone 50
15 is substantially maintained within relaxation zone 70,
heat applied during such previous impingement zone
processing tends to move inwardly into the cooler central
portions of product 15, as opposed to moving outwardly
into the ambient gases within zone 70. In this way, more
20 complete and even heating and cooking is provided in an
efficient manner while minimizing heat loss from the
system, and maximizing the uniform input of such heat to
product 15 therewithin. As shown in Figure 3, relaxation
zone 70 might also preferably be provided with a series
25 of baffles 77 designed to direct flow of processing gases
entering from adjacent impingement zones toward product
15. The resulting velocities of such baffled gases would
be substantially lower than velocities in such adjacent
impingement zones, and would serve to augment conduction
30 of heat to such product. While baffles 77 are also
illustrated below belt 31 in relaxation zone 70, it is
contemplated that they could be omitted from the lower
portion, as natural convection of heated air would likely
provide adequate upward motion of processing gases toward
35 product 15.

1 Relaxation zone 70 might also include additional
heating means (e.g. such as a heating or microwave source
98 shown in the central relaxation zone 70) for ensuring
the maintenance of the predetermined elevated temperature
5 therewithin; however, it is contemplated that the
circulation patterns within oven 10 will generally
provide sufficient heat to the adjacent tempering and/or
relaxation zones to maintain the temperature therewithin
at the desired elevated temperatures. If, however, a
10 particular desired elevated temperature is high enough
(e.g. 450° or more), it may be necessary to supplement
the heat within tempering zone 40 or relaxation zone 70
with additional thermal input.

15 As also shown in Figures 3 and 4, it is contemplated
that an exhaust system 90 would also be necessary for
safe and efficient operation of oven 10. Exhaust system
90 is shown only as an example of the many ways in which
such could be accomplished, and includes an exhaust stack
20 91 centrally located in the upper portions of middle
relaxation zone 70. Exhaust system 90 would include
appropriate exhaust manifold structure (not shown) to
draw process gases from the oven for removal. Exact
locations and numbers of such exhaust systems should be
25 designed to provide sufficient exhausting for safety and
to further control gas flow patterns, temperatures, and
the like within an oven system made in accordance
herewith. For example, exhaust systems utilizing larger
exhaust fans might cause impingement gases of several
30 successive impingement zones to be drawn toward a single
outlet, thereby influencing the gas flow pattern and
exact elevated temperatures in an intermediate relaxation
zone. Exhaust system placement could similarly be
employed to facilitate effective isolation of adjacent

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1 impingement zones by flow direction control.

While it is contemplated that a single impingement zone and a single subsequent relaxation zone may be sufficient in many applications to adequately heat and/or cook a particular product 15, it is preferred that in most applications a tempering zone 40 be utilized prior to impingement zone 50 to initiate the heating procedure and to facilitate a substantially uniform heating and cooking of the product through the process. It has also been found that the use of a plurality of alternating impingement zones and relaxation zones in seriatim enables more reliable achievement of superior browning and cooking of various food products such as chicken, turkey, other meats, fried foods, fish, and the like. In particular, vastly improved processed products are achieved by the resulting process of impinging gases at high velocity and at a predetermined elevated temperature against the outer surfaces of a food product; substantially reducing the velocity of the gases while maintaining the ambient temperature around the food product at approximately that same elevated temperature of the preceding high velocity impingement step for a predetermined period of time to enable equilibration of the temperature gradients within the food product; following such reduced velocity equilibration time period with another impingement of gases at high velocity and predetermined elevated temperatures against the outer surfaces thereof; and following such second high velocity impingement with another reduced velocity equilibration time period at approximately the same elevated temperature of such preceding high velocity impingement step to again enable equilibration of temperature gradients therewithin; and repeating such alternating steps as necessary to provide efficient and relatively

1 rapid pulse-type heating and cooking of the product at
temperatures substantially above the desired finished or
cooking temperature of the product.

5 It has been found that the interposition of
relaxation zones as described above between adjacent high
velocity impingement zones effectively isolates such
adjacent impingement zones from one another and enables
the inward migration of thermal energy which has been
10 applied to the product surface by such high velocity
impingement. This effective isolation of adjacent
impingement zones additionally enables the application of
relatively widely varying combinations of velocities,
humidities and temperatures of processing gases within
15 individual impingement zones, and such freedom to
manipulate these variables augments the substantially
limitless versatility and adaptability of ovens made
according to the present invention. The resulting
pulse-type application of thermal energy at predetermined
20 elevated temperatures substantially above the desired
finished or cooking temperature of a particular product
enables the achievement of superior product texture,
moisture content, and retention of valuable nutrients and
flavor in the processed product at relatively rapid rates
25 without overcooking or burning.

As shown in FIGS. 2 and 3, a typical continuous oven
application would include a series of alternating
impingement zones 50 and relaxation zones 70, and
30 preferably would include a tempering zone 40 (essentially
identical to a relaxation zone 70) prior to the first
impingement zone 50. While the drawing figures
specifically illustrate a pair of impingement zones 50
isolated by the respective relaxation zones 70 and
35 tempering zone 40, it is further contemplated that it may

1 often desirable to have as many as four or five or
more impingement zones 50 similarly isolated by
respective relaxation zones 70 for use with larger
products such as chickens, turkeys, or the like. It may
5 also be preferred that each such impingement zone and/or
adjacent relaxation zone be independently controlled
vis-a-vis the temperature, humidity and velocity of
processing gases therewithin. Such independent control
provides an improved oven having virtually unbounded
10 versatility and adaptability in a wide range of
processing applications.

It should also be noted that the pulse-type heating
and cooking process of the subject invention could
15 equally be adapted for use in a single cavity,
non-continuous feed or batch-type apparatus. In
particular, the steps of tempering, high velocity
impingement, and relaxation would simply be performed
sequentially within such single unit, such that periods
20 of high velocity impingement would be effectively
isolated from periods of low velocity tempering or
equilibration, while maintaining a predetermined
temperature therewithin which is substantially above the
cooking temperature of the product.

25

As mentioned above, the alternating steps of the
subject process may preferably be performed with
differing levels of humidity and/or steam introduced into
the system. In particular, the high velocity impingement
30 steps might preferably be performed with processing gases
including steam for particular applications to maintain a
desired moisture level within the product during
processing. Similarly, particular velocities of the
processing gases might desirably be varied between
35 successive impingement zone applications, or even between

1 impingement from upper and lower plenums of a single
impingement zone. It can, therefore, be seen that the
resulting oven system and process of the subject
invention is quite versatile and can be adapted to
5 practically any product cooking and/or heating
application. In this regard, it is further contemplated
that the heating and cooking steps involved herein could
also be augmented by the implementation of microwave
energy during any of the particular steps set forth
10 herein. For example, the continuous food oven 10 of
FIGS. 2 and 3 might be modified to include a source of
microwave energy (e.g. shown at 98 of FIGS. 2 and 3) to
augment the application of heat to product 15 within
equilibration zone 40. Likewise, such microwave energy
15 could also be provided in any of the subsequent
impingement zones 50 and/or relaxation zones 70, as
desired.

Figure 5 illustrates a preferred manner of arranging
20 supply conduit 89 to provide communication between
heating chamber 86 and lower plenum 54 (it should be
noted that conveyor system 30 has not been included in
this view). In particular, impingement zone 50 is shown
as including a front wall 59 having a pair of oppositely
25 hinged door-like members 59a and 59b. It is contemplated
that members 59a and 59b would preferably provide
substantial and easy access to the interior of
impingement zone 50 for maintenance, inspection, cleaning
and the like. In this regard, it is preferred to route
30 supply conduit 89 in door member 59b between lower
heating chamber 86 and lower plenum 54 to similarly
facilitate access thereto. Other ways of hingedly or
removably mounting supply conduit 89 and/or front wall 59
could also be employed to provide access to conduit 89
35 and the interior portion of impingement zone 50.

1 Member 59b is shown as being formed with an arcuate
conduit portion 59c and a removable panel 59d which
serves to define conduit 89 therewithin. When in closed
position (as shown in Fig. 4), conduit 89 connects the
5 output channel 68 adjacent lower blower fan 67 with an
input manifold 69 of lower plenum 54. As further
illustrated in Figures 3 and 4, it is preferred to
include turning vanes 95 within lower plenum 54 to
uniformly distribute the heated processing gases within
10 plenum 54 to ensure more uniform impingement via tubes
52. Turning vanes 95 can comprise one or more shaped
fins or baffles designed to evenly direct incoming flow
of processing gases within lower plenum 54. Addition-
ally, as shown best in Figure 2, it is preferred to
15 alternate which side of oven 10 on which conduit 89 is
located for successive impingement zones 50 to more
evenly distribute impingement flow from the respective
lower plenums of such zones.

20 The vertical spacing from the distal ends of tubes
52 is preferably adjustable relative conveyor 30 and,
particularly, product 15 on conveyor 30, to enable
further control of processing gas velocities and
impingement patterns on such product. Such vertical
25 adjustability can most easily be provided by designing
plenum 53 to be vertically adjustable relative belt 31.
Any arrangement which would enable vertical adjustment
between those parts, however, could be employed. It is
contemplated that to enable such movement of plenum 53,
30 either the entire upper portion of impingement zone 50
might be vertically adjustable relative belt 31 and the
lower portions of zone 50, or, alternatively, a sliding
fit between supply conduit 84 and the movable plenum 53
could be provided.

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The vertical spacing between the upper distal ends
of lower tubes 52a is preferably predetermined and

1 non-adjustable to ensure an impingement pattern against
belt 31 and/or product 15 which provides for downward
return flow of such gases without substantially
interfering with the upward impingement pattern. While
5 lower plenum 54 of impingement zone 50 could be made
vertically adjustable, as described with respect to upper
plenum 53 above, it is preferred to maintain tubes 52a at
a predetermined distance below belt 31 and product 15 to
enable gas flow as illustrated in FIG. 4. As seen,
10 processing gases issuing from tubes 52a spread outwardly
in a substantially conical manner to impinge product 15.
Proper spacing of tubes 52a from one another and from
belt 31 provides a substantially "dead" space through
which gases can recirculate downwardly and laterally to
15 be returned to heating chamber 86, as described herein.
Such downward movement, in conjunction with the abrupt
change in direction of such gases above the water in moat
55, facilitates removal of suspended grease and similar
impurities from the processing gases prior to
20 recirculation to the heating chambers. Such impurities
tend to be deposited in the water moat for removal. In
combination with other filtering systems (e.g. mechanical
filters 92 described above), ovens made in accordance
herewith can run continuously much cleaner and safer over
25 extended periods of time without requiring major
cleaning. Continuous, uninterrupted operation of ovens
over extended periods of time (i.e. substantially
constant operation) can, therefore, be realized by
incorporation of the various unique features of the
30 subject invention.

As indicated above, baffles 77 may also preferably
be provided within relaxation zone 70 to direct the flow
of processing gases toward product 15. Where the tubes
35 (e.g. 52 and 52a) of adjacent impingement zones 50 are

1 vertically adjustable, it is further contemplated that
baffles 77 can be correspondingly adjustable therewith.
As best seen in FIG. 6, it is preferred that baffles 77
be rotatably fixed at their upper end, such as by pins
5 78, and linked by adjustment arm 79 at their distal ends
to corresponding adjustable plenums 53 and 54. As
indicated by the phantom lines of FIG. 6, as plenum 53 is
vertically adjusted, baffles 77 would thereby be
correspondingly adjusted to properly and optimally direct
10 processing gases toward belt 31 and product 15 carried
thereon. It should be noted that the exact manner of
providing corresponding adjustment of baffles 77 with
adjacent impingement zone tubes is not critical, and the
adjustment arm assembly is included only as an example of
15 a preferred structure.

As described above, the predetermined elevated temp-
eratures utilized within an oven are expected to be
variable between particular applications, and to be
20 determined based on a number of variables related to the
product and desired heating and/or cooking characteris-
tics of the particular process contemplated. Conven-
tional low-temperature cooking of products is often
accomplished at a temperature of approximately 200° F
25 (93° C) or less.

On the other hand, browning of various food products
and the like is often accomplished in a temperature range
of between about 800° F (427° C) and about 1000° F (538°
30 C). High-temperature cooking is often undertaken in a
temperature range of between about 450° F (232° C) to
about 600° F (315° C). It has been found that the unique
pulse-type method of heating and cooking food products as
set forth in the subject invention disclosure can achieve
35 superior heating and cooking characteristics in various

1 products utilizing the substantially constant processing
temperature (predetermined elevated temperature T) in a
range of between about 250° F (121° C) to 600° F (315°
5 C). Consequently, the process of the subject invention
can achieve superior results in a much more economical
manner than heretofore available. For example, it has
been found that whole chickens can be cooked and properly
browned in an oven made in accordance herewith in as
10 little as 32 minutes utilizing processing gases in the
oven in a temperature range of between about 300° and
350° F (between about 149° C and 176° C). In a conven-
tional convection-type oven generally used for this
purpose in the industry, about two hours is nominal
15 cooking time. It has also been found that the method and
apparatus of the subject invention provides processed
food products having superior flavor, texture and
moistness characteristics while minimizing product yield
losses which normally occur during cooking. An
20 additional advantage of the subject invention can be seen
in a continuous feed oven application, wherein the
individual impingement zones, relaxation zones, and
tempering zones can be manufactured in modular form so
that systems can be mass-produced and easily combined in
accordance with requirements of the user.

25 Various modifications of the described invention
will be apparent to those skilled in the art. Examples
of several of such variations have been mentioned and
discussed above. Further adaptations could be made in
30 order to customize a particular system for a specific
use. For example, relaxation zones 70 could be equipped
with manifold plates and jet tubes as described with
regard to impingement zones 50, for application of low
velocity processing gases to the products. Such
35 modification is not particularly preferred in that it

1 would substantially increase the ~~co~~ of the individual
zones of the resulting continuous feed oven; however it
might be desirable in situations where, for example, it
is important to continually impinge the surface of the
5 product with moisture-laden air or in order to create a
self-basting action of the product throughout the
process. In other applications, the initial
equilibration zone (i.e. tempering zone 40) might be
omitted, wherein product would pass directly into first
10 impingement zone 70. Accordingly, the scope of the
present invention should be considered in terms of the
following claims and is understood not to be limited to
the details of structure and operation described and
shown the specification and drawings.

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1 **WHAT IS CLAIMED IS:**

1. A continuous feed oven for heating and cooking food product, said oven comprising:

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 (a) a conveyor means for continuously moving product through said oven along a substantially longitudinal path;

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 (b) a plurality of spaced impingement zones located along said longitudinal path, said impingement zones each comprising a plurality of spaced jet tubes for impinging gases at predetermined humidity and elevated temperatures and at predetermined high velocities against the outer surfaces of product being conveyed on said conveyor means; and

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 (c) a relaxation zone integrally interposed between adjacent impingement zones, said relaxation zone effectively isolating adjacent impingement zones from one another and providing an equilibration space having a temperature therewithin substantially equal to the predetermined elevated temperatures of the preceding impingement zone, and wherein the velocity of movement of said gases is substantially lower than in said adjacent impingement zones, whereby product passes through a series of alternating impingement and relaxation zones such that an effective thermal pulsing heat application is provided to the product, and the predetermined elevated temperatures throughout the oven are constantly maintained substantially above the desired finished temperature of the product.

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2. The continuous feed oven of claim 1, wherein the predetermined humidity, elevated temperatures, and high

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1 velocities of said impinging gases within a particular
impingement zone can be controlled independently of other
impingement zones of the oven.

5 3. The continuous feed oven of claim 1, wherein
said spaced jet tubes of said impingement zones are
located both above and below said conveyor means for
simultaneously impinging the product on said conveyor
means from both above and below.

10 4. The continuous feed oven of claim 3, wherein the
velocities of gases being impinged from above and below
said conveyor means within a particular impingement zone
can be controlled independently of one another.

15 5. The continuous feed oven of claim 1, wherein a
relaxation zone is integrally associated at both the
front and rear longitudinal ends of each impingement
zone.

20 6. The continuous feed oven of claim 1, wherein
said oven further comprises microwave equipment to
augment heating and cooking of the product within at
least one of the interconnected zones thereof.

25 7. The continuous feed oven of claim 6, wherein the
microwave augmentation is limited to one or more of said
relaxation zones.

30 8. The continuous feed oven of claim 1, wherein said
predetermined elevated temperatures are maintained within
a range of between 250° F and about 600° F, and wherein
the connection of said impingement zones and said
relaxation zones minimizes temperature gradients there-
35 within along substantially the entire longitudinal length

1 of said oven.

5 9. The continuous feed oven of claim 3, said oven further comprising conduit means for routing said impinging gases to said spaced jet tubes both above and below said conveyor means at least a portion of such conduit means being removably mounted to said oven to facilitate access thereto for repair and maintenance.

10 10. The continuous feed oven of claim 1, wherein said relaxation zone further comprises baffle means for directing processing gases entering from an adjacent impingement zone toward product being conveyed on said conveyor means.

15 11. The continuous feed oven of claim 1, wherein said jet tubes of at least one of said impingement zones are vertically adjustable relative said conveyor means.

20 12. A continuous feed oven for heating and cooking food product, said oven comprising:

25 (a) a conveyor means for continuously moving product through said oven along a substantially longitudinal path;

30 (b) a plurality of spaced impingement zones located along said longitudinal path, said impingement zones each comprising a plurality of spaced jet tubes for impinging gases at predetermined humidity and elevated temperatures and at predetermined high velocities against the outer surfaces of product being conveyed on said conveyor means;

35 (c) a control means for independently

1 controlling said predetermined humidity, elevated
temperatures and high velocities of said impinging gases
within the individual impingement zones; and

5 (d) a relaxation zone integrally interposed
between adjacent impingement zones, said relaxation zone
effectively isolating adjacent impingement zones from one
another and providing an equilibration space having a
temperature therewithin substantially equal to the
10 predetermined elevated temperatures of the preceding
impingement zone, and wherein the velocity of movement of
said gases is substantially lower than in said adjacent
impingement zones, whereby product passes through a
series of alternating impingement and relaxation zones
15 such that an effective thermal pulsing heat application
is provided to the product, and the predetermined
elevated temperatures throughout the oven are constantly
maintained substantially above the desired finished
temperature of the product.

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13. The continuous feed oven of claim 12, wherein
said spaced jet tubes of said impingement zones are
located both above and below said conveyor means for
simultaneously impinging the product on said conveyor
25 means from both above and below.

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14. The continuous feed oven of claim 13, wherein
the velocities of gases being impinged from above and
below said conveyor means within a particular impingement
zone can be controlled independently of one another.

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15. The continuous feed oven of claim 12, wherein a
relaxation zone is integrally associated at both the
front and rear longitudinal ends of each impingement
zone.

1 16. The continuous feed oven of claim 12, wherein
said oven further comprises microwave equipment to
augment heating and cooking of the product within at
least one of the interconnected zones thereof.

5 17. The continuous feed oven of claim 16, wherein
the microwave augmentation is limited to one or more of
said relaxation zones.

10 18. The continuous feed oven of claim 12, wherein
said predetermined elevated temperatures are maintained
within a range of between 250° F and about 600° F, and
wherein the connection of said impingement zones and said
relaxation zones minimizes temperature gradients there-
15 within along substantially the entire longitudinal length
of said oven.

 19. The continuous feed oven of claim 13, said oven
further comprising conduit means for routing said
20 impinging gases to said spaced jet tubes both above and
below said conveyor means.

 20. The continuous feed oven of claim 12, wherein
said relaxation zone further comprises baffle means for
25 directing processing gases entering from an adjacent
impingement zone toward product being conveyed on said
conveyor means.

 21. The continuous feed oven of claim 12, wherein
30 said jet tubes of at least one of said impingement zones
are vertically adjustable relative said conveyor means.

 22. A continuous feed oven for heating and cooking
food product, said oven comprising:

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1 (a) a conveyor means for continuously moving
product through said oven along a substantially longitudinal path;

5 (b) a plurality of spaced impingement zones
located along said longitudinal path, said impingement
zones each comprising a plurality of spaced jet tubes
located both above and below said conveyor means for
10 simultaneously impinging gases at predetermined humidity
and elevated temperatures and at predetermined high
velocities against the outer surfaces of product being
conveyed on said conveyor means from both above and
below;

15 (c) a control means for independently
controlling said predetermined humidity, elevated
temperatures and high velocities of said impinging gases
within the individual impingement zones; and

20 (d) a relaxation zone integrally interposed
between adjacent impingement zones, said control means
further independently controlling said humidity,
temperatures and velocities of gases issuing from said
jet tubes above and below said conveyor means,
25 respectively and said relaxation zone effectively
isolating adjacent impingement zones from one another and
providing an equilibration space having a temperature
therewithin substantially equal to the predetermined
elevated temperatures of the preceding impingement zone,
30 and wherein the velocity of movement of said gases is
substantially lower than in said adjacent impingement
zones, whereby product passes through a series of
alternating impingement and relaxation zones such that an
effective thermal pulsing heat application is provided to

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1 the product and the predetermined elevated temperatures
throughout the oven are constantly maintained
substantially above the desired finished temperature of
the product.

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23. The continuous feed oven of claim 22, wherein
said oven further comprises microwave equipment to
augment heating and cooking of the product within at
least one of the interconnected zones thereof.

10

24. The continuous feed oven of claim 22, said oven
further comprising conduit means for routing said
impinging gases to said spaced jet tubes both above and
below said conveyor means.

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25. The continuous feed oven of claim 22, wherein
said relaxation zone further comprises baffle means for
directing processing gases entering from an adjacent
impingement zone toward product being conveyed on said
20 conveyor means.

25

26. The continuous feed oven of claim 22, wherein
said jet tubes of at least one of said impingement zones
are vertically adjustable relative said conveyor means.

25

27. A continuous feed oven for heating and cooking
food product, said oven comprising:

(a) a conveyor means for continuously moving
30 product through said oven along a substantially longitud-
inal path;

(b) a plurality of spaced impingement zones
located along said longitudinal path, said impingement
35 zones each comprising a plurality of spaced jet tubes

1 located both above and below said conveyor means for
simultaneously impinging gases at predetermined humidity
and elevated temperatures and at predetermined high
velocities against the outer surfaces of product being
5 conveyed on said conveyor means from both above and
below;

(c) conduit means for routing said impinging
gases to said spaced jet tubes, at least a portion of
10 said conduit means being removably mounted to said oven
to facilitate access thereto;

(d) a control means for independently
controlling said predetermined humidity, elevated
15 temperatures and high velocities of said impinging gases
within the individual impingement zones; and

(e) a relaxation zone integrally interposed
between adjacent impingement zones, said control means
20 further independently controlling said humidity, tempera-
tures and velocities of gases issuing from said jet tubes
above and below said conveyor means, respectively; and
said relaxation zone effectively isolating adjacent
impingement zones from one another and providing an
25 equilibration space having a temperature therewithin
substantially equal to the predetermined elevated temp-
eratures of the preceding impingement zone, and wherein
the velocity of movement of said gases is substantially
lower than in said adjacent impingement zones, whereby
30 product passes through a series of alternating impinge-
ment and relaxation zones such that an effective thermal
pulsing heat application is provided to the product and
the predetermined elevated temperatures throughout the
oven are constantly maintained substantially above the
35 desired finished temperature of the product.

1 28. A method of heating and cooking food products,
comprising the steps:

5 (a) impinging gases at predetermined high
velocity and at a predetermined humidity and elevated
temperature substantially above the desired finished
temperature of the product against the outer surfaces of
a food product;

10 (b) substantially reducing the velocity of
said gases while maintaining the ambient temperature
around the food product at approximately the same
elevated temperature as in the preceding impingement step
15 for a predetermined period of time to enable equilibra-
tion of the temperature gradients within the food
product;

20 (c) following such reduced velocity
equilibration time period with another impingement of
gases at high velocity and at a predetermined humidity
and elevated temperature substantially above the desired
finished temperature of the product against the outer
surfaces of the food product; and

25 (d) following such second high velocity
impingement step with another reduced velocity
equilibration time period at an elevated temperature
approximately equal to the elevated temperature of the
preceding impingement step to again enable equilibration
30 of temperature gradients within the food product, whereby
the reduced velocity equilibration steps are alternated
with said high velocity impingement steps to effectively
isolate such high velocity impingements from one another
and to enable efficient and relatively rapid, pulse-type
35 cooking of the food product at temperatures substantially

1 above the desired finished temperature of the product.

29. The method of claim 28, further comprising a
first step of tempering the food product prior to the
5 first high velocity impingement step by subjecting the
food product to relatively low velocity gases having a
temperature approximately equal to the predetermined
elevated temperature of the first succeeding impingement
step.

10

30. The method of claim 28, wherein the gases
impinged upon the food product during separate high
velocity impingement steps are impinged at different
velocities to vary and control the amount of thermal
15 energy applied to the product during each such
impingement step.

31. The method of claim 28, wherein the gases
impinged upon the food product during separate high
20 velocity impingement steps are impinged at different
temperatures to vary and control the amount of thermal
energy applied to the product during each such
impingement step.

32. The method of claim 28, wherein the gases
impinged upon the food product during separate high
velocity impingement steps are impinged at different
humidities to vary and control the amount of thermal
energy applied to the product during each such
30 impingement step.

33. The method of claim 28, wherein the method is
completed in a continuous manner within an apparatus
having a plurality of connected zones corresponding to
35 the alternating high velocity impingement and reduced

1 velocity equilibration steps hereof.

34. The method of claim 33, wherein at least some
of the gases from adjacent high velocity impingement
5 zones of the continuous apparatus are recirculated within
the apparatus through the interposed low velocity
equilibration zones.

35. The method of claim 28, further comprising the
10 additional step of augmenting the heating and cooking of
the food product with microwave energy during one or more
of the steps.

36. The method of claim 28, wherein each high
15 velocity impingement step is both preceded and followed
by a step of subjecting the food product to lower
velocity gases at elevated temperature substantially
above the desired finished temperature of the product.

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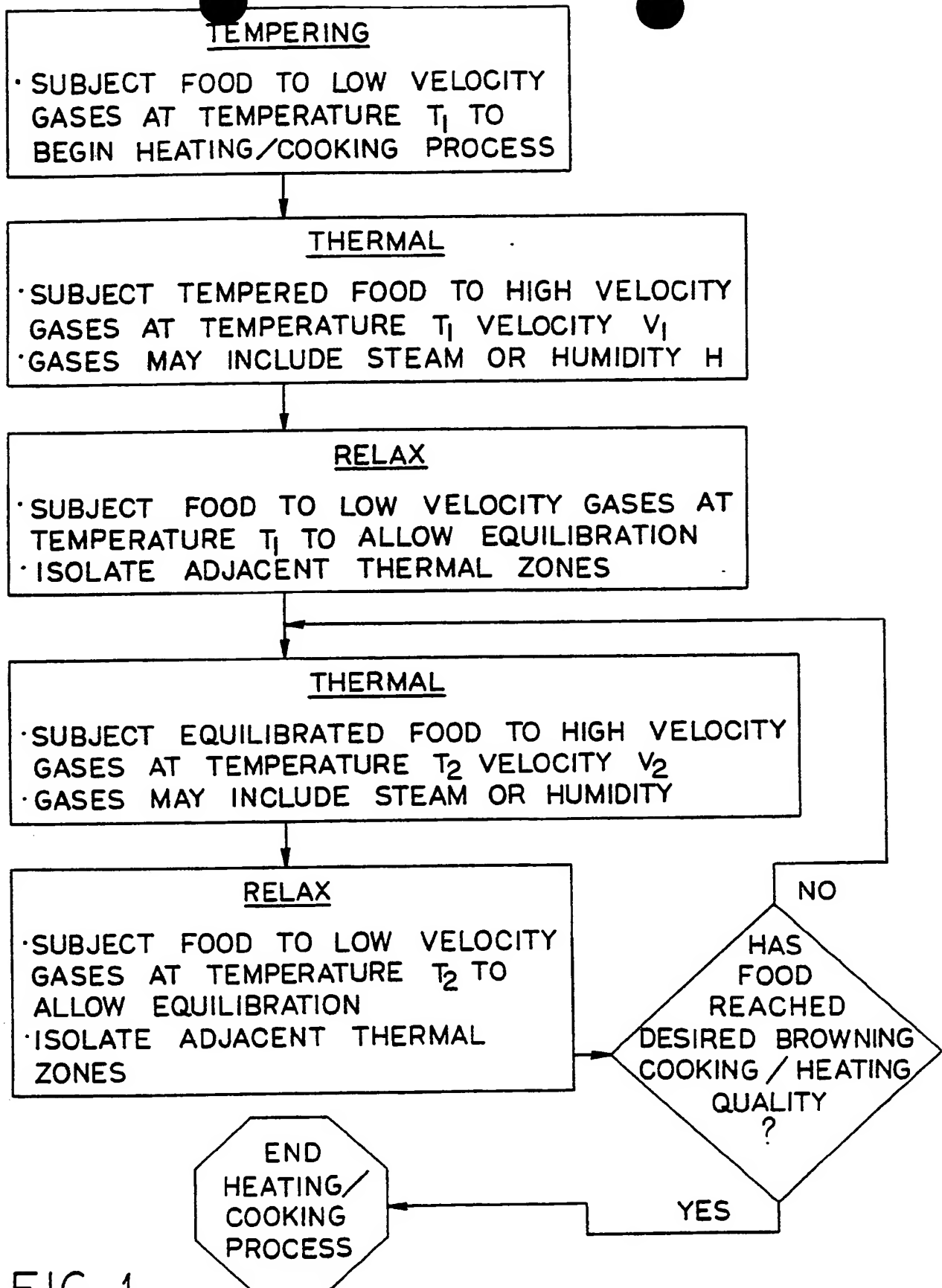


FIG. 1

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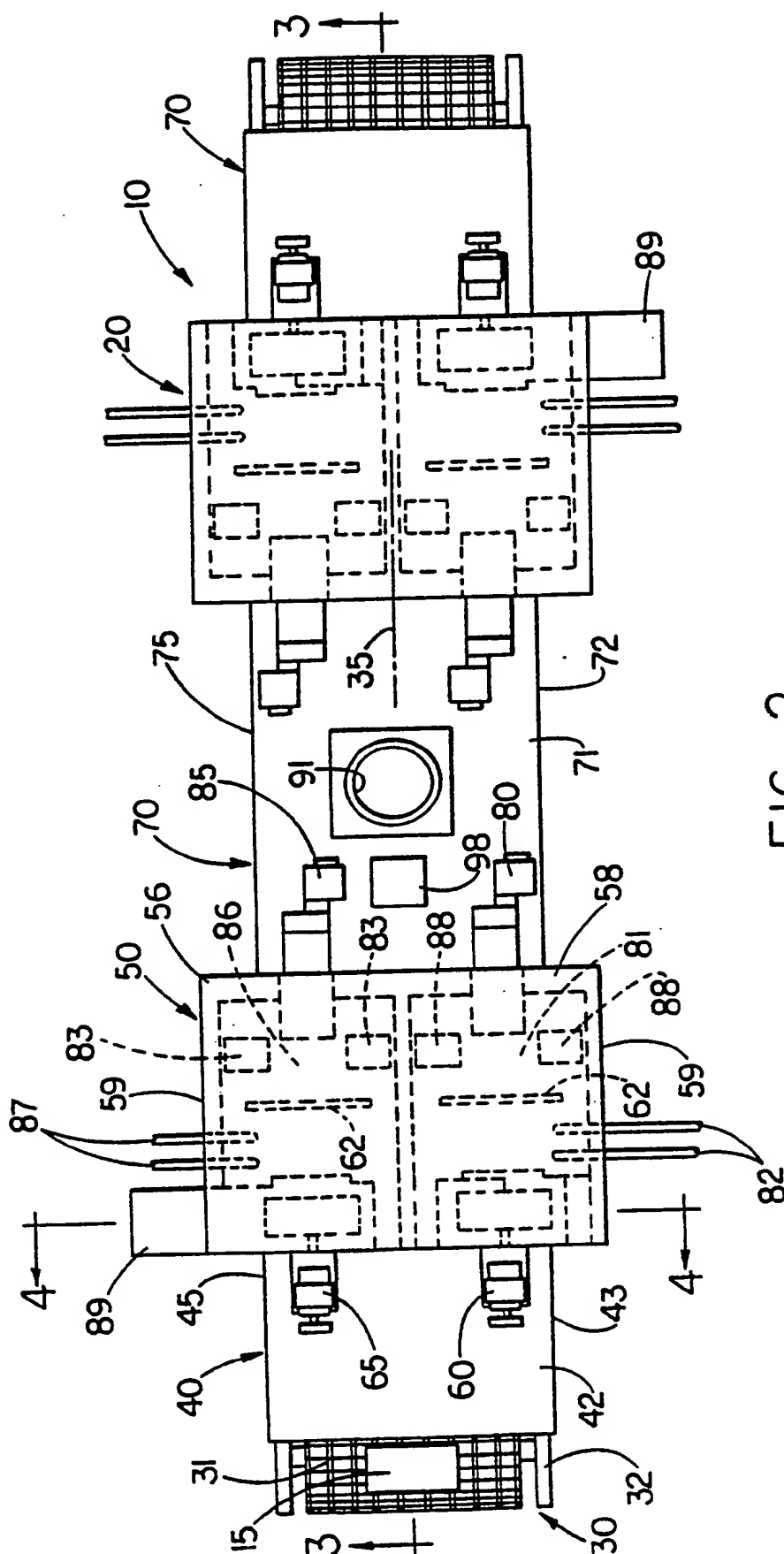


FIG. 2

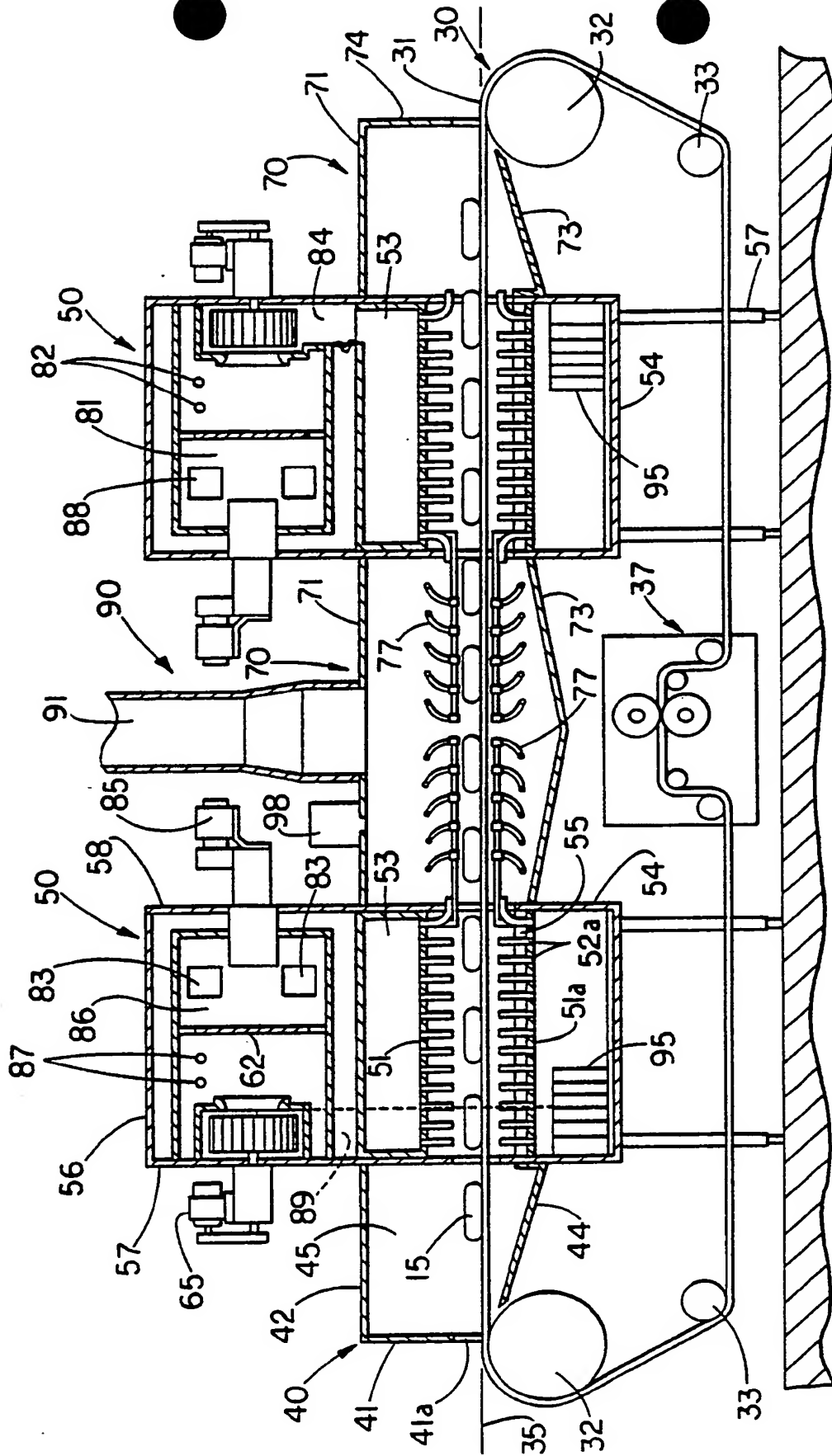


FIG. 3

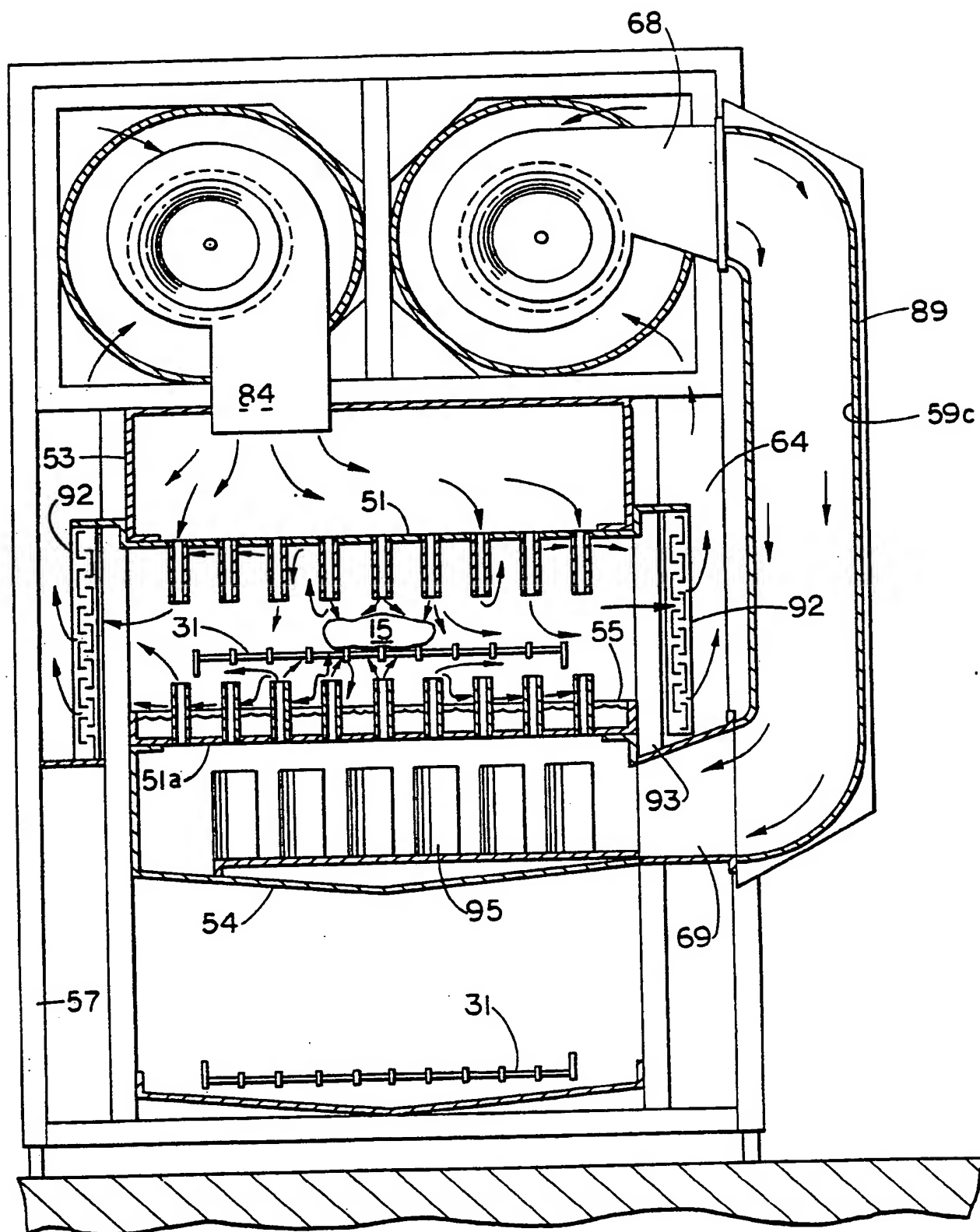


FIG. 4

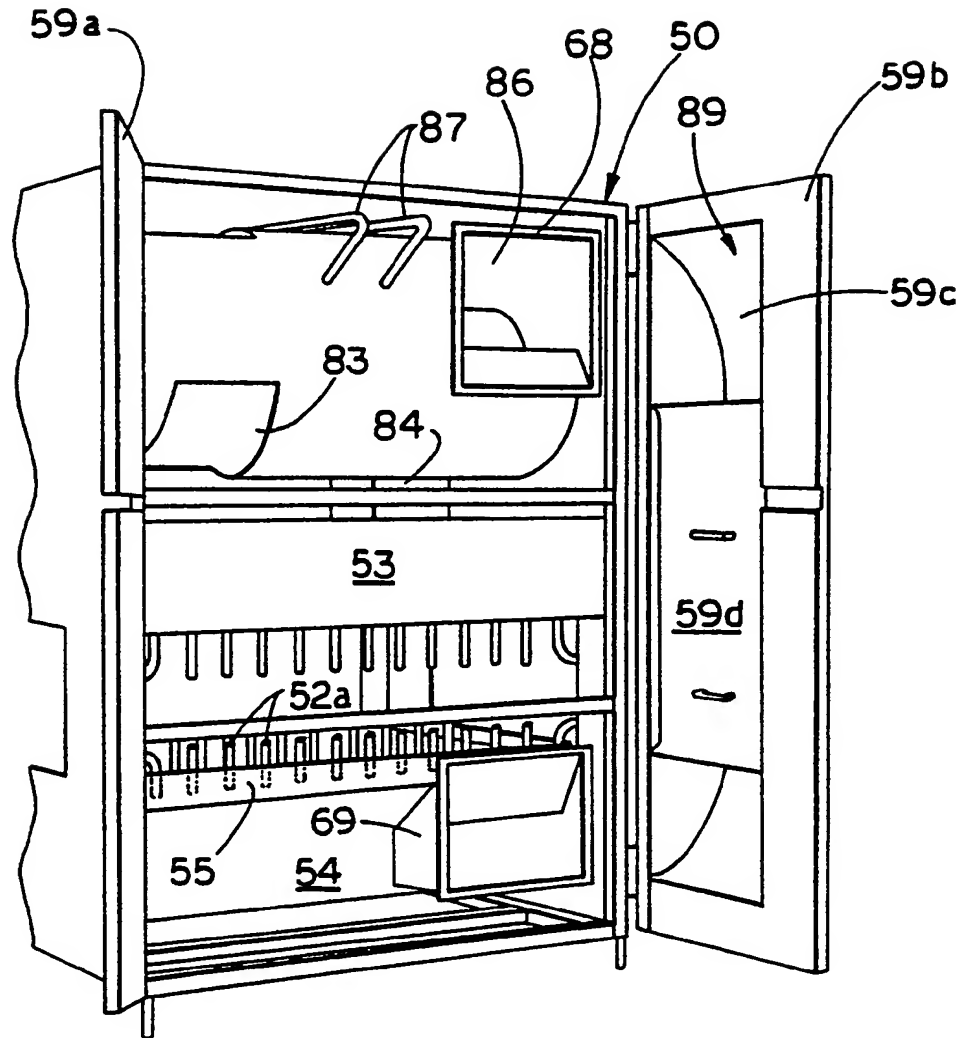


FIG. 5

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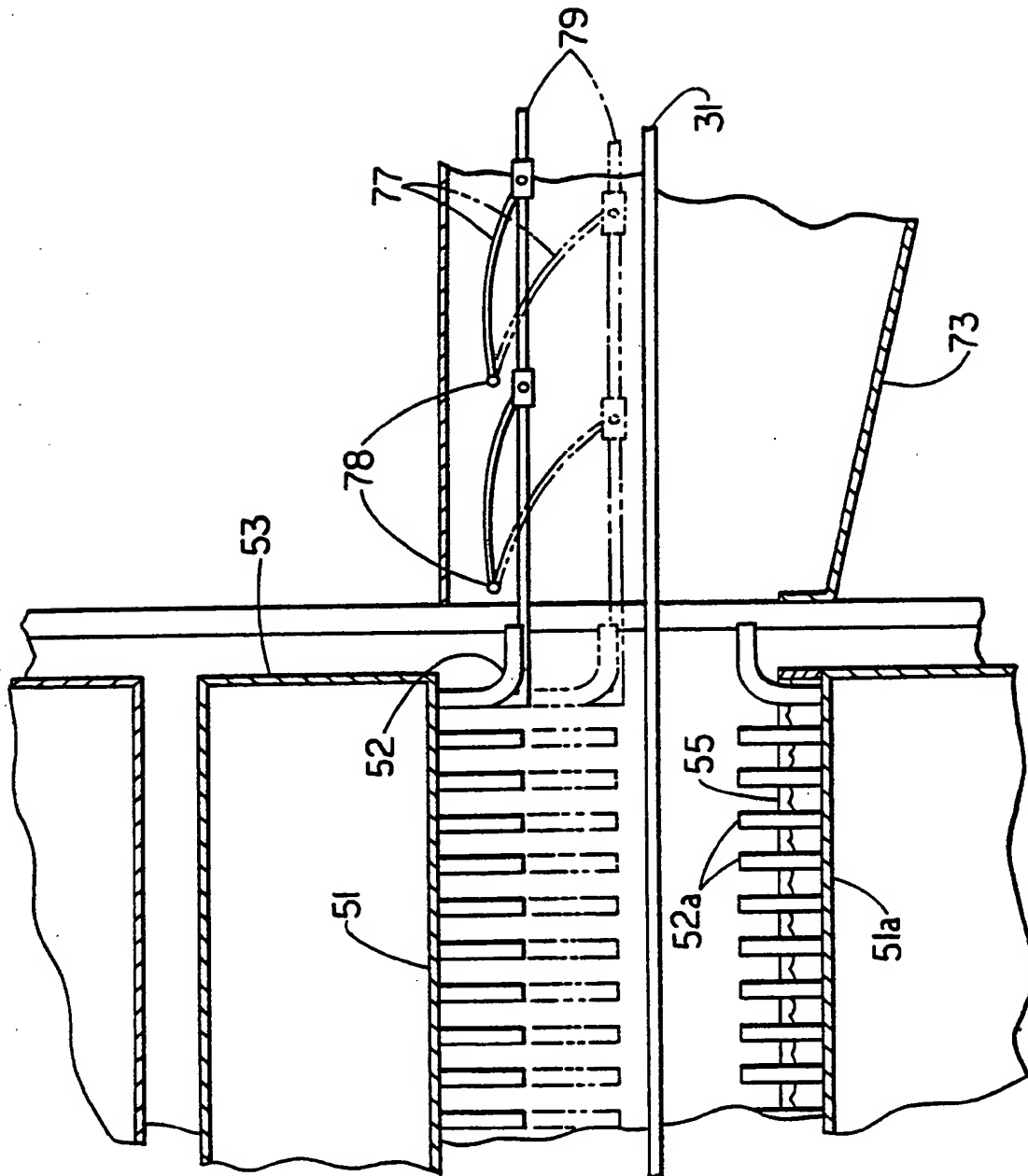
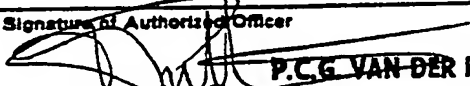


FIG. 6

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁴ : A 47 J 39/00; A 23 L 1/01		
II. FIELDS SEARCHED		
Minimum Documentation Searched *		
Classification System	Classification Symbols	
IPC ⁴	A 47 J; F 24 C; A 23 L	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	EP, A, 0086568 (PATENTSMITH INC.) 24 August 1983 see the whole document	1-5, 8, 9, 12-15, 18, 19, 22, 24, 25, 27-31, 33
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A	EP, A, 0226350 (LINCOLN FOODSERVICE PRODUCT INC.) 24 June 1987 see the whole document	1
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A	US, A, 4409453 (SMITH) 11 October 1983 see the whole document cited in the application	1, 6

<p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
18th August 1988	19. 09. 88	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	 P.C.G. VAN DER PUTTEN	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

US 8801485
SA 22263

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 12/09/88. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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		JP-A- 58180120	21-10-83
		US-A- 4474498	02-10-84
		US-A- 4479776	30-10-84
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		US-A- 4492839	08-01-85

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